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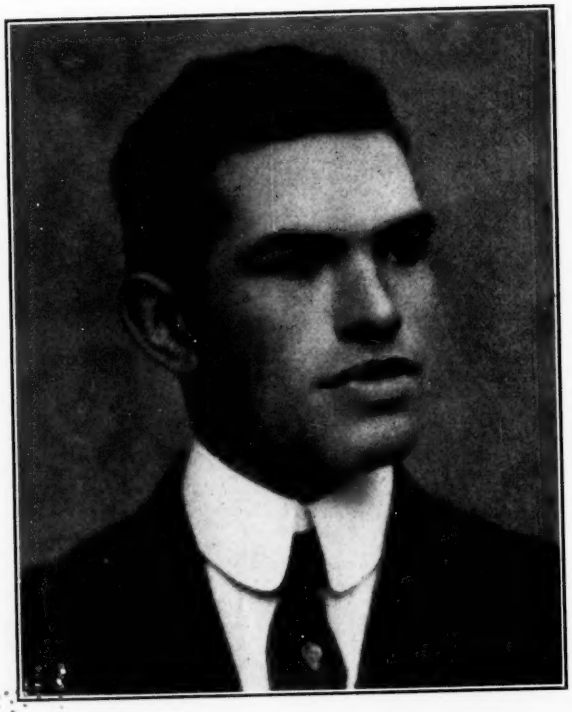

VERN BONHAM STEWART

PHYTOPATHOLOGY

VOLUME IX NUMBER 3

MARCH 1919

VERN BONHAM STEWART

DONALD REDDICK

WITH PORTRAIT FIGURE

Vern Bonham Stewart was born in Avilla, Indiana, January 26, 1888, and died at Newark, New Jersey, December 3, 1918. He passed from the public schools of the State to Wabash College, where he had the good fortune to come under the influence of an inspiring man and an unusual teacher of botany, Mason B. Thomas. On graduation from Wabash in 1909, with the degree A.B., Stewart was appointed industrial fellow in Plant Pathology at Cornell University and at once began investigations, some of which were continued almost without interruption until his death.

In June, 1913, Stewart was granted the degree of Doctor of Philosophy for work in course. His thesis was entitled "The fire blight disease in nursery stock." The work contains a very complete account of the behavior of *Bacillus amylovorus, in vitro,* but is notable chiefly for the very complete account of its occurrence, dissemination, and manifestations under field conditions at all seasons. The methods of control proposed were tested thoroughly.

Upon completion of his probational work Doctor Stewart was appointed to a research position as Assistant Professor of Plant Pathology in Cornell University and the next five years were given almost exclusively to work on diseases of horticultural and ornamental nursery stock.

The work on control of fire blight led to further studies on insect transmission of the blight organism on which subject were published a number of papers. Considerable work was done on the control of various fungous diseases but all such work was supplemented by laboratory studies and control measures were based on an intimate knowledge of the fundamental principles involved. The paper entitled "Some important leaf diseases of nursery stock" will be found to contain much original work and the recommendations made show the greatest familiarity with the details of nursery practice.

Nurserymen came to rely on Stewart for advice; and his intimate knowledge of their special problems and conditions made his advice to them of inestimable value. Pathologists relied on him for pure culture of *Bacillus amylovorus* and for eight years he was able at any time to respond to the requests which came from all parts of the world for a viable culture of the organism in active pathogenic state.

In July, 1918, Doctor Stewart took up emergency work for the United States Department of Agriculture in connection with the Food Products Inspection Service and exposure in connection with this work led to the fatal attack of pneumonia. He had made already notable progress in this neglected phase of plant pathology.

Stewart was deeply interested in his chosen profession. He was a regular attendant at the meetings of the American Phytopathological Society and took an active part in the affairs of the Society. As associate editor of PHYTOPATHOLOGY he rendered valuable assistance in the editorial work. He was a sustaining member of the Society, Fellow of the American Association for the Advancement of Science, member of the Botanical Society of America and of Sigma Xi.

Stewart can be said fairly to have struck his gait. Each succeeding work reveals a clearer vision and a keener insight into the fundamentals of the science. One can but reflect on the loss to society and to science of one whose brief scientific career gave evidence of such great fruitfulness.

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1910 Fire blight of pears, apples, quinces, etc. New York Cornell Agr. Exp. Sta. Bul. **272**: 31–52, illus. Co-author with H. H. Whetzel.

1911 Peach leaf curl in nursery stock. (Abstract.) Phytopathology **1**: 107.

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1913 The importance of the tarnished plant bug in the dissemination of fire blight in nursery stock. Phytopathology. **3**: 273–276, pl. 23.

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1915 Notes on the fire blight disease. Phytopathology **5**: 327–334.

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1916 The leaf blotch of horse-chestnut. New York Cornell Agr. Exp. Sta. Bul. **371:** 411–419, fig. 85–92, pl. 10 (col.).
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1918. Some Verticillium diseases. Phytopathology **8:** 15–19.
1918. Dusting experiments in 1917. Phytopathology **8:** 63–64.
1918. Some Verticillium diseases. (Abstract.) Phytopathology **8:** 75. Co-author with I. C. Jagger.
1918 Exclusion legislation and fruit tree production. Phytopathology **8:** 360–364.
1918 Varieties of beans susceptible to mosaic. Phytopathology **8:** 530–534. Co-author with D. Reddick.

PHILIPPINE PLANT DISEASES[1]

OTTO REINKING

Fungous diseases are found on practically all cultivated and wild plants in Laguna Province, Island of Luzon, in the Philippine Islands. The climatic conditions there are particularly favorable for the occurrence of the diseases which are often the limiting factors in the production of many agricultural crops. Naturally, these diseases are most common and destructive during the rainy seasons of the year. No estimates have been prepared of losses due to plant diseases in the Philippines. However, it would be safe to say that in this section of the Islands at least 10 per cent of the agricultural crops are destroyed by fungous pests.

The seriousness of some of the diseases can be judged by the fact that the coffee industry of the Islands was wiped out by a disease. The coconut industry suffers severely in certain sections from destruction of the trees due to bud rot, and rice culture is hampered by numerous fungous diseases. This is also true of the sugar and citrus industries and the culture of all vegetables.

The great factors in the spread and destructiveness of various pathogenes are the lack of proper culture, sanitation, pruning and spraying. The native farmer gives little attention to his crops after they are planted and ignorance and lack of foresight with respect to plant diseases and their control account for a great part of the loss. Furthermore there is reluctance on the part of the natives to adopt methods which will prevent losses from plant diseases and at the present time there is need for educating the farmer along this line. At present practically no spraying is carried on in the Islands. A disease survey and provision for inspection by properly trained inspectors is desirable.

In order to give some idea of the prevalence of plant diseases a list with short descriptions has been prepared. While this list is not complete and takes into consideration only those diseases found in Laguna and nearby provinces in the Island of Luzon, it will be seen that practically all agricultural crops are attacked by fungous parasites. Many of these diseases have proved to be caused by species of fungi new to science.

[1] The author makes grateful acknowledgment to Dr. V. B. Stewart for a careful reading of this manuscript.

The contributions to our knowledge of these new species have been due largely to the collections of C. F. Baker whose work, with that of the European mycologists H. Rehm, H. Sydow, P. Sydow, N. Patouillard, and G. Bresadola, has been published in Leaflets of Philippine Botany, edited by A. D. E. Elmer, Vol. VI., articles 95, 102, 103, 104 and 105; and Vol. VII., article 113; the Philippine Journal of Science, Vol. VIII, Sec. C., No. 3, pages 181, 195; No. 4, pages 251, 265; No. 5, pages 299, 391; No. 6, page 475; Vol. IX, Sec. C., No. 2, page 157; No. 4, page 345; and Vol. X, Sec. C., No. 2, page 85; as well as writings in the Philippine Agriculturist and Forester, Vol. III., No. 7 and Vol. V., No. 3.

Ananas sativus PINEAPPLE

Pineapples are not grown on a commercial scale in the Philippines, and the native fruits are relatively free from fungous attacks. There are several fruit rots, but as yet the causal organisms have not been determined. Some rots appear to be bacterial, starting at injuries in the fruits.

LEAF SPOT. The lower leaves of pineapples are frequently and often seriously attacked by *Asterinella stuhlmanni* (Henn.) Theiss. The spots when young are small, slightly elongated and yellow to light brown in color. The lesions extend rapidly, become dark brown and often cover the entire leaf. Older spots are often raised, due to the shrinkage of the surrounding tissue, and have light brown centers covered with minute black perithecia. The fungus causes the premature death of the lower, older leaves.

Annona muricata SOURSOP OR GUABANO

A common fruit tree grown in all parts of Luzon.

LEAF SPOT. *Phyllosticta insularum* Sacc. causes a common and sometimes destructive leaf disease. The spots are irregular, starting at the margins, and grey to whitish in color.

Arachis hypogaea PEANUT

Peanuts are extensively grown in the Philippines and are attacked by various fungi.

LEAF SPOT. The leaf spot caused by *Cercospora personata* (B. & C.) Ellis may be extremely destructive on certain varieties of peanuts. The disease is most severe during damp weather. Both leaves and stems are attacked. The lower leaves are most severely affected and complete defoliation of this portion of the plant may occur. The spots on the leaves are usually circular in outline, brown to black in the center, with a yellowish discoloration of the surrounding leaf tissue. The masses

of conidia and conidiophores are apparent in the center of older lesions. The spots on the stem are similar, but are usually elongated in a direction parallel to the length of the stem. Certain varieties of peanuts show marked degrees of resistance.

In Java the leaf spotting of the peanut is attributed to *Septogloeum arachidis* Racib. Further study will probably show that the Philippine leaf spot disease is also caused by a species of Septogloeum.

ROOT ROT. Peanuts are frequently attacked by a Sclerotinia-like fungus causing a rot of the root and lower stems. Sclerotial bodies are always associated with the disease but as a rule it does not cause serious damage and no study has been made of the causal organism.

Artocarpus incisa BREAD FRUIT

The diseases affecting bread fruit are fruit rot (*Rhizopus artocarpi* Racib.) and leaf spot (*Cercospora artocarpi* Syd.). The leaf spot causes little damage. *Diplodia artocarpi* Sacc. may be found on languished leaves.

Artocarpus integrifolia JAK-FRUIT

FRUIT ROT OR BLIGHT. *Rhizopus artocarpi* Racib. may attack the inflorescence and young jak-fruit. The blossom is killed by the fungus. Young fruits five to ten centimeters long are subject to attack, the disease usually starting at the stem end or in injuries, causing a soft rot. The decay gradually advances until the entire fruit rots and drops from the tree. This fungus appears to be a true parasite. Typical sporangia and sporangiophores are produced, covering the decayed fruit. The disease is not widespread, but may cause injury in certain localities.

Besides the Rhizopus rot, dying leaves of the jak-fruit may be attacked by *Diplodia artocarpina* Sacc, and *Dichotomella areolata* Sacc.

Beta vulgaris cicla CHARD

LEAF SPOT. *Cercospora beticola* Sacc. which causes the leaf spot of the beet in the United States has been observed in the Philippines on Swiss chard. Leaves of Swiss chard may be entirely covered with the characteristic lesions, which are at first small and brownish to black in color. Older spots are circular, often five centimeters in diameter, and brownish, and may exhibit concentric rings. The oldest spots have an ashen grey center but no purple borders around the spots have been observed. Groups of yellowish conidiophores bearing hyaline, needle-like conidia are produced abundantly in the center of the lesions.

Brassica chinensis PECHAY

Pechay is a common vegetable grown in the Philippines.

LEAF SPOT. Frequently *Cercospora brassicicola* Henn. causes a severe spotting of pechay leaves, making the plant unfit for market. Characteristic Cercospora spots with ashen-grey centers bordered with light brown, are produced. *Cercospora armoraciae* Sacc. has also been found on *Brassica chinensis*.

Brassica oleracea BRUSSELS SPROUTS

BLACK ROT. This destructive cabbage disease, caused by *Pseudomonas campestris* (Pammel) Smith has made its appearance in the Islands upon Brussels sprouts. The geographical distribution and occurrence of the disease on different hosts has not been determined. The characteristic yellowing of the leaves at the margins, and the blackened veins are produced. Cross sections of diseased petioles show the blackened fibrovascular bundles. Pure cultures of the bacteria indicate that the organism is the same as that occurring in the United States.

Capsicum annuum RED PEPPER

ANTHRACNOSE. *Colletotrichum nigrum* Ellis and Halsted causes a disease of red peppers characterized by the production of soft, often circular, sunken spots on the fruit. Small black spore-bearing bodies are produced in the center of the spots. The disease is common, causing a rotting of the fruit.

BACTERIAL WILT. *Bacillus solanacearum* Smith, which is so destructive on other solanaceous plants, attacks the peppers also. *Phomopsis capsici* (Magnaghi) Sacc. also occurs on dried pods.

Vermicularia capsici Syd. causes a fruit rot of *Capsicum frutescens* which is similar to the rot on *C. annuum* caused by *Colletotrichum nigrum*.

Carica papaya PAPAYA

This common tropical fruit is attacked by several different fungi.

FRUIT ROT. Frequently a species of Fusarium causes the decay of mature fruit. The rot is similar to that caused by Phytophthora, except that the surface of this rot is covered with the dense growth of Fusarium mycelium. Fusarium spores are produced in abundance.

Phytophthora faberi Maubl. also may cause a soft rot of the mature fruit. The rots starts usually at some injury and spreads until the entire fruit is involved. Conidia and oospores are developed by the fungus. Often species of Rhizopus and Penicillium are associated with these rots.

LEAF SPOT. *Mycosphaerella caricae* Syd. may attack papaya plants severely, causing a lack of vigor and premature dropping of the older leaves. Circular spots, from a few millimeters to a centimeter in diameter, are produced. Older spots have an ashen-grey center and are bordered with darker brown, concentric rings. The minute perithecia are produced in the center of older spots.

Aspergillus periconioides Sacc. is commonly found on weakened falling leaves. *Colletotrichum papayae* (Henn.) Syd., *Diplodia caricae* Sacc., and *Didymella caricae* Tassi have been found on dead and dying petioles.

Citrus spp.

Citrus culture is conducted in certain sections of the Islands but as with the majority of the other fruit crops, little attention is given to pruning, spraying and cultivation. Consequently the trees are sickly and in many cases severely attacked by insects and fungi.

CANKER. This infectious and destructive canker disease, caused by *Bacterium citri* Hasse, is present in the Islands. It occurs on the commonly planted citrus fruit, *Citrus nobilis* (Satsuma orange, Canton mandarin), but seems to do little damage. The disease is, however, severe in the college plantation at Los Baños, Laguna, where test varieties are grown. The susceptibility of different varieties to the canker disease is somewhat in the following order: *Citrus grandis* (large pomelo, bitter pomelo, Djersek Boli), large orange, Lisbon lemon, Washington navel, rough lemon, *Citrus hystrix* (wild lime), *Citrus medica* (citron), *Citrus nobilis* (Satsuma orange, Canton mandarin), *Citrus torosa* (Colobot), *Citrus japonica*, small orange, Kusaie lime, and *Citrus mitis* (Calamondin).

This list is based on young plantings and it is probable that the order of susceptibility will change somewhat as observations continue.

Citrus grandis is the species most severely affected by the canker disease at the college farm. Great damage is done to young trees, often resulting in death. Older trees grown by the natives in the vicinity of this college are attacked, but as in the case of *Citrus nobilis*, the damage produced is slight.

Characteristic lesions of the disease occur on the leaves, stems and fruit of citrus. The spots on the leaves are at first small, watery, round and slightly raised. Later these lesions enlarge, turn brown, become raised on one or both sides of the leaf, and form ruptures at the surfaces which extend through the leaf. Concentric irregular rings may be produced in the brown discolored area, which is surrounded by a light yellow border. Frequently spots coalesce, producing an elongated, brownish, raised, ruptured blotch. In many cases a leaf-mining insect becomes

infested with the bacteria and in the winding trail of the insect a chain of canker spots develop.

At first the spots on the twigs are similar to those on the leaf, but later they become irregular, brown, raised and spongy, often with a dark brown border. The spots are cankerous and persistent, but are formed only in the outer layers of the bark tissue. Frequently twigs are entirely encircled by cankers, but they do not seem to be killed outright in all cases.

Spots on the fruit, in the first stages, are similar to those on the leaf. They may be scattered, but frequently run together, forming irregular, brown, raised, cankerous blotches. Where large blotches occur, the surface of the fruit is depressed or slightly shrunken. Cankers do not penetrate deeply below the surface and seem to cause little damage other than producing an unsightly appearance. Gumming of the fruit is associated with the disease in some cases, but this is not general.

DAMPING-OFF. Damping-off of seedlings is found, undoubtedly being caused by a species of Sclerotinia.

DIE-BACK. Die-back is common in poorly kept orchards. No definite causal organism has been assigned. Many fungi are found on the dead and dying twigs, including the following: on *Citrus nobilis: Zignoella nobilis* Rehm., *Eutypella citricola* Speg., *Valsaria citri* Rehm., *Massarina raimundoi* Rehm., *Tryblidiella rugula* (Spreng). Sacc., *Diaporthe citrincola* Rehm., and *Tryblidiella mindanaoensis* Henn., and on *Citrus decumana: Eutypa heterocantha* Sacc. *Nectria episphaeria* (Tode) Fr. was found parasitic on *Eutypa heterocantha*. *Cytospora aberrans* Sacc. and *Hypoxylon atropurpureum* Fr. are also found on coccids infesting dead twigs, while *Aschersonia sclerotoides* Henn. grows parasitically on coccids that infest citrus leaves. A sooty mould fungus has likewise been observed growing on the sugary exudate of aphids which covers the leaves, stems and fruit.

GUMMOSIS. Citrus trees are frequently affected with gummosis of the trunk, stem and fruit. The disease of the stems is more severe in poor, ill-kept orchards. Insect punctures in the fruit have been observed to cause a gumming, while mechanical, or fungous injuries, as in the case of citrus canker, may cause gummosis. It appears that the gummosis of stems and fruits of citrus trees in the Islands is not caused by any one definite organism or factor.

LICHENS. Lichens are found in abundance, growing over all woody parts and even leaves of citrus trees. The damage done appears to be slight, though the normal physiological conditions of the plant are disturbed. Lichens can be reduced by the use of a six per cent copper sulphate solution or by judicious spraying. Epiphytes occur also on poorly kept plantations but these can be easily removed by pruning.

Among other troubles are root rots, the cause of which has not been determined, scaly bark, which causes a sloughing and is apparently due to insect attacks just below the bark, and some undetermined rots of picked fruits.

Phyllosticta circumsepta Sacc. has been found on the dying rind of fruit.

Cocos nucifera COCONUT

BUD ROT. This bud rot is the most serious coconut disease in the Philippine Islands. Fortunately it is found only in a few localities of the coconut regions, chiefly in La Laguna and Tayabas provinces. These coconut sections are some of the most extensive in the Islands and unless control measures are carried out the disease will spread to other regions.

The first symptom is a withering of the youngest unfolded leaf, which later turns brown. Gradually other leaves wither and turn brown until the entire central group of leaves is affected. At this stage the disease is easily recognized by the group of dead young leaves, or central bud, which has become brown. Often some of the largest leaves of the bud have fallen over. This diseased central portion is surrounded by older leaves, on the outside, which are healthy and remain upon the tree until they drop naturally. Trees are usually affected when they first come into bearing. All older bearing trees may be attacked, but the young trees, not in bearing, are seldom affected. The young nuts, on trees affected by the disease, remain small and fall prematurely. Bud rot is most severe on trees grown in regions of great moisture.

The internal symptoms of the disease on trees in advanced stages are very characteristic. A longitudinal section of the bud shows no evidence of insect injury. The outer leaves of the bud are killed and browned. The upper portion of the cabbage, inside of these leaves, is entirely softened by a bacterial decay and has the consistency of soft cheese. The rot extends down into the heart of the trunk for about 1.5 meters below the tip of the central bud. The limit of the disease is, therefore, well down into the trunk in the mature portion of the tree. The decay usually penetrates only 30 to 45 cm. and is checked when it reaches the firmer tissues of the trunk. The affected portion in the trunk of the tree is very soft and has a vile odor which is somewhat sour. The limits of this internal rot, on the sides, and along the lower line of advancement into the trunk, are marked by a reddish brown discoloration.

Advanced stages of the disease are characterized by the white cabbage changing into a semi-liquid mass with an ill smelling odor. The decayed portion of the trunk of the tree consists of fibers in a semi-liquid mass.

Microscopic examination of recently invaded tissue showed no evidence of mycelium, but an abundance of bacteria was observed. Pieces of diseased tissue collected in the field and placed immediately in sterilized vials developed no fungus but were completely invaded by bacteria. A bud rot was produced in young trees by inoculating with bacteria isolated from diseased trees in the field. Sufficient work has not been done to determine the specific organism causing the bud rot disease but the results obtained would indicate that the disease is of a bacterial nature.

Trees when once affected never recover. The mode of growth of the palms and the nature of the disease make it impossible to cure trees already infected. The only control method so far determined is that of prevention. All diseased trees should be cut down and the diseased portions completely burned or buried deeply with lime. If this precaution of burning all infected trees is carried out under strict supervision, the danger of the spread of the disease is largely eliminated.

LEAF SPOT. *Exosporium durum* Sacc. causes a leaf spot which is characterized by the production of black tubercular or wart-like sporodochia on the surface of the leaves. These spots are scattered, or sometimes densely crowded on the leaf surface. In some cases the sporodochia may be surrounded by a somewhat discolored area of the leaf. The sporodochia have no spines. The conidia are borne on conidiophores and are yellowish to brown in color and septate. This disease is not common and causes but little damage.

LEAF SPOT. The leaf spot disease caused by *Pestalozzia palmarum* Cke. is common throughout all coconut sections. As a rule it is not serious and causes little damage. The vitality of the trees is lowered and in a few cases, especially on younger trees, the spotting may become severe. Spots often are scattered over the entire leaf-surface. Young infections are characterized by small brown to black circular raised spots a few millimeters in diameter. Older spots, which often coalesce, are irregularly circular to slightly oblong in shape and from 1 and 1.5 to 3 cm. long. These spots have a light brown to ashen grey center and are bordered by a narrow dark brown ring. The characteristic minute black acervuli are produced in the center of the spots. The spores are septate, with the central cells yellowish and the end cells hyaline. Two to four hyaline setae are produced at one end of the spore and usually only one at the other end.

In severe cases of infection of young trees, spraying with Bordeaux mixture is advisable. Sanitation in the form of burning dead and diseased leaves is always practical.

SOOTY MOULD. Frequently a sooty mould is developed on the under surface of the leaves. This is due to the fungus *Capnodium footii* Berk. & Desm. growing on the honey dew of coccids. The disease is not serious.

STERILITY OF NUTS. Frequently nuts are found which are composed entirely of husk. No meat or shell is developed within the husk. The disease is undoubtedly a non-parasitic one, being due to some abnormal physiological condition of the plant. Root diseases are also present but their cause has not been determined. *Thielaviopsis ethaceticus* Went., which causes the stem bleeding disease, has not been observed.

Other fungi found upon the coconut include the following: *Chaetosphaeria eximia* Sacc., and *Phyllosticta cocophila* Pass., on mature dying leaves; *Anthostomella cocoina* Syd. on dead petioles; *Palawania cocoes* Syd., on dead spathes; *Rosellinia cocoes* Henn., on dead peduncles; and *Eutypella cocos* Ferd. & Winge., *Diplodia cococarpa* Sacc., *Diplodia cococarpa* var. *Malaccensis* Tassi., *Cytospora palmicola* B. & C., and *Peroneutypella cocoes* Syd., on husks.

Coffea spp. COFFEE

LEAF SPOT. A leaf spot produced by *Micropeltis mucosa* Syd. is found on *Coffea excelsa* but it is only of slight importance. The perithecia appear as minute black, scale-like, raised spots scattered over the upper and lower surfaces of the leaf. They are usually more abundant on the lower side of the leaf. The fungous growth is superficial. The leaf spot caused by a species of Cercospora has not as yet been observed on coffee in the Philippines.

No important root or stem diseases have been observed, however, *Coniothyrium coffeae* Henn. has been found on twigs of *Coffea arabica*.

STEM ROT. Coffee seedlings are frequently attacked on the stem just at and above the ground by a species of Sclerotinia. Infected stems are blackened and somewhat shrunken. The fungus may also spread to the leaves causing a black advancing rot. The disease is most severe during the rainy season and on seedlings kept in damp places. Young plants are killed by the fungus. In pure culture the fungus produces numerous small, smooth, round, brown, sclerotial bodies. Inoculation experiments have proved the parasitism of the fungus isolated, but no spore production has been observed. A species of Rhizoctonia also causes a similar stem rot.

RUST. This widely distributed and destructive disease caused by *Hemileia vastatrix* B. & Br. has wiped out the coffee industry in various sections of the Islands. Orange-red roundish spots cover the under surface of the leaves. Infected leaves wilt and drop and repeated attacks cause death to the entire plant. Young spots appear as transparent slightly yellowish discolorations. As the spot becomes older the yellow coloration increases until finally a yellow dust, which turns to orange, is produced on the under surface of the leaves. The disease is most severe

and evident during the rainy season. *Coffea arabica* which is the best commercial coffee grown in this region, is severely affected by the rust and has been practically wiped out in most sections. A few favorably situated districts, as in high altitudes, still produce Arabian coffee successfully. Owing to the rust disease, *Coffea arabica* is now of relatively slight importance in Java. Many plantations have been uprooted and replanted to the Robusta type or hybrid varieties.

Control measures consist in selecting resistant varieties and spraying with Bordeaux mixture. In the Philippines, as shown by the College of Agriculture plantings, *Coffea liberica* seems to be practically free from attack. *Coffea robusta* is only slightly susceptible while *Coffea arabica* is severely affected. The Liberica varieties need a special pulper, and the Robusta coffee is of relatively poor quality and commands a low price. The Arabian coffee (*Coffea arabica*), is the most easily handled and is very productive, therefore, for the Philippines the best control measure is spraying. Spraying experiments have shown that the disease can be controlled with Bordeaux mixture at a cost of ten centavos a tree per year.

Colocasia antiquorum GABI

BLIGHT. Gabi, which is extensively grown in the Philippines, suffers severely from the attacks of *Phytophthoracolocasiae* Racib. The leaf blades, petioles and corms are attacked. The young leaf spots which are two to three centimeters in diameter are dark and watery, and exude drops of a yellow liquid. Older and larger spots have yellowish-brown centers bordered by broad, watery rings. Frequently the margins have concentric rings of brown or yellow. When spots coalesce, covering the entire leaf, a soft, watery, disintegrating leaf is produced.

In severe cases the petioles may become infected. The fungus gradually invades the petiole, which becomes blackened, shrunken and watery, and finally collapses. The entire diseased leaf then decomposes into a watery mass.

Infection of the corms may occur in severe attacks and during damp weather. The disease produces a wet rot, causing the corms to disintegrate.

A delicate white growth consisting of the conidia produced on short conidiophores is apparent on the diseased areas. The conidia are large, thin-walled, smooth and colorless, and have a short broad papilla. No oospores have been observed. Infection takes place by the conidia (sporangia) which are scattered chiefly by water.

The disease is most severe during the rainy season. Control measures consist in the growing of disease-resistant varieties. Spraying with

Bordeaux mixture is not effective. *Xanthosoma sagittifolium*, a heavy yielding yautia, is not attacked by the Phytophthora and should replace the ordinary gabis.

Cucumis sativus CUCUMBER

A species of Cercospora causes an irregular to angular, light greenish leaf spot of cucumbers but the disease is not destructive. On rotting snake gourd, *Trichosanthes anguina*, two fungi are found, *Discothecium bakeri* Syd. and *Macrophoma trichosanthis* Syd.

Daucus carota CARROT

STEM ROT. During damp weather a stem rot of the carrot may be abundant. The stems are attacked just at and above the ground. The infected stems become brown, shrivel up and cause the death of the leaf by cutting off the water supply. Isolations and pure culture work showed the causal organism to be a species of Rhizoctonia.

Dioscorea YAMS

LEAF SPOT. *Cercospora ubi* Racib. and *Cercospora pachyderma* Syd. produce two common leaf spots on yams. The leaves may be moderately spotted but generally only slight injury is done. *Phyllachora dioscoreae* (Schw.) Sacc. also occurs, producing stromatic bodies which are thinly scattered over the leaves. Little damage is done.

RUST. The two rust fungi, *Uredo dioscoreae* (Berk. & Brm.) Petch. and *Uredo dioscoreae-alatae* Racib., are common and occasionally destructive. The characteristic yellowish rust pustules are developed on the under surface of the leaf.

STORAGE ROTS. Storage rots are present in abundance. A frequent cause is a species of Lasiodiplodia which produces its characteristic sooty mass of spores on the surface of the dry rotted roots.

Phoma oleracea Sacc. is found on dead stems.

Ficus carica FIG

RUST. *Kuehneola fici* (Cast.) Butl. which is also known as *Uredo fici* Cast. causes a disease which may be very severe, resulting in defoliation of the trees, especially during the rainy season. Brownish, raised sori develop on the under surface of the leaf and opposite the sori small, light, discolored spots are produced on the upper surface of the leaf. Usually only uredospores are produced.

Figs are not grown commercially in the Philippine Islands. The leaves of wild figs, of which there are many species in the Islands, are commonly spotted with the characteristic stromata produced by species of the genus Phyllachora.

Soja max SOY BEAN, SOJA

BLACK MILDEW. Frequently entire patches of soy beans appear yellowish and sickly. This may be due to the attacks of a fungus which produces numerous small black pycnidia on the under surface of the leaves. As yet the fungus is unidentified.

BLIGHT. During the rainy season entire fields of soy beans may be destroyed by a species of Sclerotinia. The disease is most severe in close plantings and practically all kinds of plants growing in a matted condition may be attacked. Besides different varieties of beans, the disease has been observed on African peanuts, *Voandezia subterranea*, and on weeds growing among the infected plants. The blight is not so common on plants which are grown on a trellis or in uncrowded conditions, where there is plenty of aeration. The stems, leaves and pods of the soy bean are all severely affected and the fungus starts from the ground, growing up the older hardy stem to the tender portions, or attacks the tender portions directly if they are touching the ground. The mycelium of the fungus can be easily seen growing over the plants in a whitish mass and spreading from plant to plant. Infected leaves are at first somewhat yellowed in blotches and gradually turn black and disintegrate into a soft mass. Leaves of infected plants touching healthy plants afford a means of spreading the fungus. The disease extends from the infected leaves down to the tender stems and even to the more mature stems causing them to decay forming a watery mass. The fungus mycelium penetrates to all parts of diseased portions, undoubtedly producing an enzyme which aids in the disintegration of the tissue. As the leaves and stems disintegrate, and especially during dry weather, countless numbers of sclerotial bodies are produced. These sclerotia are at first white and soft, but soon turn brown and hard. They are sometimes roughly spherical and from 1 to 3 mm. in diameter, or they may be somewhat flattened, elongated and often 6 mm. in length. The diseased leaves and sclerotia fall to the ground and during favorable weather the sclerotia develop mycelium which produces new infections. The disease is not severe during the dry season or during the drier periods of the rainy season but it spreads with remarkable rapidity during favorable weather.

Numerous inoculation experiments have been conducted using different beans as hosts. The sclerotia from pure cultures were placed on leaves or tender stems and the plants put under bell glasses. Within

two days infections of blight were apparent. The sclerotia produce mycelium directly infecting injured or uninjured tissue and within one week the entire plant is blighted and falls over in a soft mass. Later sclerotial bodies are formed on the diseased plants. The advance of the fungus could be retarded or completely checked by removing the bell glasses and placing the infected plants in the sunlight. Reisolation from infected plants yielded the same fungus as that used for the inoculations. Spores have not been observed on diseased plants or in cultures of the fungus and attempts to produce spore bearing bodies and spores, from sclerotial bodies have thus far failed.

RUST. Frequently soy beans are severely attacked by *Uromyces sojae* (Henn.) Syd. Characteristic brown rust sori are scattered thickly over the under surface of the leaves. The spots are at first rounded, raised, brown blisters, but later they burst open exposing the spores. On the upper surface of diseased leaves the tissue is yellowed opposite the sori.

Gossypium spp. COTTON

Cotton is not grown to any extent in the Islands; however, it is planted in a few localities for home use.

RUST. *Uredo desmium* (Berk. & Br.) Petch. (*Aecidium desmium* B. & Br.) is a common leaf rust found at the college on *Gossypium herbaceum* and *Gossypium braziliense*. Infected leaves are entirely covered on both surfaces with minute brownish to black pustules.

Hibiscus sabdariffa ROSELLE

BLIGHT. A stem blight is rather severe on Roselle, often killing entire plants. The causal organism is an imperfect fungus which as yet has not been identified. Diseased stems are attacked, chiefly at the base of small branches and the internodes may also be attacked. The spots spread until they encircle the twigs. They are black with grey centers and specked with pycnidia.

On dead twigs may be found *Phoma sabdariffae* Sacc.

Ipomoea batatas SWEET POTATO

STORAGE ROT. A common dry storage rot, characterized by the production of a sooty mass of spores on the outside of infected potatoes, is caused by a species of Lasiodiplodia.

Lactuca sativa LETTUCE

TIP BURN. This non-parasitic disease is common during the dry season. The leaves turn brown at the tip and gradually shrivel.

Lycopersicum esculentum TOMATO

BACTERIAL WILT. The bacterial wilt caused by *Bacillus solanacearum* Smith is often the limiting factor in the production of tomatoes, it being impossible to grow tomatoes in soil which is thoroughly infested with the organism.

The first evidence of the disease is a wilting of the plant, which later shrivels, turns yellowish and then brown to black. A discoloration of the vascular bundles is observed in cross section and a microscopic examination shows the vascular bundles to be entirely clogged with bacteria. In advanced stages the organism may invade the parenchyma. The symptoms for the bacterial wilt of the other Solanaceous plants are similar to those of the tomato. Care should be taken to keep the disease producing organism out of non-infested soil. Strict sanitary measures should be practiced. Insects are undoubtedly great factors in the spread of the disease in the tropics.

DAMPING-OFF. Damping-off of seedlings is common with plants grown in unsterilized soil. This is true of all vegetables grown in seed flats. A species of Rhizoctonia and a fungus similar to *Pythium de baryanum* Hesse. are associated with the disease.

DOWNY MILDEW. A downy mildew probably caused by *Phytophthora infestans* (Mont.) de Bary has been observed on the under surface of tomato leaves. Only a few infected plants have been seen and no complete study was attempted.

Several fruit rots of tomato also occur but the causal organisms have not been determined.

Mangifera indica MANGO

The mango is an important commercial fruit tree attacked by a number of fungi none of which is extremely destructive.

LEAF SPOT. A common leaf spot caused by *Cercospora mangiferae* Koord. is often abundant and without question does some damage. *Leptothyrium circumscissum* Syd. is also occasionally found destroying leaves by attacking the whole leaf surface. Other leaf fungi are *Meliola mangiferae* Earle, producing a superficial growth on the leaves; and *Pestalozzia funerea* Desm., which is found on weakened leaves. *Endoxyla mangiferae* Henn., has been found on dead limbs.

Manihot dichotoma CEARA RUBBER

Rubber trees are not grown commercially on the Island of Luzon, consequently little work has been done with diseases affecting them.

However, *Phyllosticta manihoticola* Syd. is a common leaf spot of ceara rubber trees and may sometimes cause severe damage.

Manihot utilissima CASSAVA OR CAMOTING CAHOY

Cercospora henningsii Allesch. is present on the cassava, but not abundant enough to cause any great damage. Diseased spots are irregularly circular in shape, and brown. Other fungi found on dead and dying branches of the cassava are *Diplodia manihoti* Sacc., *Guignardia manihoti* Sacc. and *Colletotrichum lussoniense* Sacc.

Morus alba MULBERRY

As yet the mulberry is not extensively grown, owing to the fact that the silk industry is not well developed. The plant is, however, subject to fungus attacks where grown.

POWDERY MILDEW. *Phyllactinia suffulta* (Rebent.) Sacc. is more or less common, producing the characteristic powdery appearance on the under surface of the leaves.

RUST. *Kuehneola fici* (Cast.) Btl. occurs commonly and produces the characteristic brownish raised sori and rusty powder of spores on the under surface of leaves, as described for the rust of the fig.

TWIG FUNGI. Several fungi are found on dead and dying mulberry twigs, among them being the following: *Traversoa dothiorelloides* Sacc. & Syd., *Botryodiplodia anceps* Sacc. & Syd., *Valsaria insitiva* Ces. & de Not., *Diplodiamori* West.

Musa paradisiaca sapientum BANANA

STEM ROT. A stem rot occurs in the banana similar to that on abaca. The disease is not very serious and probably is due to bacteria. None of the true bud rots has yet been observed in a destructive form. A blasting of the young fruit also occurs frequently but is undoubtedly due to other causes than fungi. A fungus, *Diplodia crebra* Sacc., has been associated with the diseased fruits, but is probably not the cause of the trouble.

As yet no root diseases have been found, but certain species of Basidiomycetes have been observed among the stumps at the base of the plants.

LEAF SPOT. Older banana leaves with lowered vitality are often severely attacked by *Macrophoma musae* (Cke.) Berl. & Vogl. Leaves whipped by wind are more subject to attack and usually a definite striping is produced, but a general infection may take place. The disease is characterized by the formation of blackish to brownish stripes extending from the mid-rib to the edges. The surface of diseased leaves is roughened due to the black pycnidia which are rather large and are produced in enormous numbers. Frequently they are compacted, forming circular blackish, raised spots. Since only the older leaves with lowered vitality

are attacked, the disease is not a serious one. Burning of the infected fallen material is advised. Another fungus, *Sporodesmium bakeri* Syd. may be found associated with the Macrophoma leaf spot but it is of little importance. *Plicaria bananincola* Rehm. is found on dead plants.

LEAF SPOT. A common leaf spot found in almost all banana plantations is caused by *Mycosphaerella musae* Speg. This disease, which is of little importance, is characterized by the formation of definite spots, usually somewhat elongated, from 5 mm. to 2.5 cm. in length. The spots may have a greyish center surrounded by a black ring or they may be blackened throughout, usually with a darker black border. In the center of the greyish portion are the minute black perithecia. Spots frequently coalesce and if the leaf is badly infected a general browning may occur.

Musa textilis ABACA

BACTERIAL STEM ROT. A soft rot affecting the central part or heart of abaca stems is reported from various sections of the Islands. As yet little work has been done with this disease, due to its scarcity in this vicinity. In this section the disease affects only older stems of reduced vitality. It is undoubtedly due to bacteria.

LEAF SPOTS. Leaf spots of abaca which are similar to those on banana are produced by *Mycosphaerella musae* Speg. and *Macrophoma musae* (Cke.) Berl. & Vogl. The diseases are not serious and cause but little damage.

Nicotiana tabacum TOBACCO

Tobacco culture is very extensive in certain sections of the Islands and diseases are present, but none is of much importance.

BACTERIAL WILT. Tobacco plants may be badly diseased with the common bacterial wilt of Solanaceous plants caused by *Bacillus solanacearum* Smith. No serious epidemics in tobacco plantations have been reported. However, they may occur at any time unless the organism is kept in check. Plants 15 cm. to 1 meter in height are noticeably affected. Wilting is the first indication of the disease and later a brown stripe is produced running chiefly from the petioles of the leaves down the stem. A slight shrinkage in the brown striped portion may occur. Diseased plants die prematurely.

CURING AND FERMENTING TROUBLES. Troubles during curing and fermenting are experienced by the manufacturers but no study has been made of the fungi causing the trouble.

DAMPING-OFF OF SEEDLINGS. Tobacco seedlings are especially susceptible to damping-off diseases and plants in seed flats may be affected.

A study of the fungi causing this condition revealed the presence of a species of Rhizoctonia and *Pythium de baryanum* Hesse.

Damping-off of seedlings is also very general and severe with flower and vegetable seedlings. In the majority of cases the Rhizoctonia fungus was found and the latter was usually associated with a fungus similar to *Pythium de Baryanum* Hesse. A species of Sclerotinia was also found to cause a damping-off or stem rot of coffee seedlings as previously stated. These troubles can be easily avoided by soil sterilization.

LEAF SPOT. A bacterial leaf spot has been observed on tobacco during the rainy season under conditions of excessive moisture. The lower leaves are severely attacked and the spots are irregularly circular, 5 mm. to 3 cm. in diameter, having brownish grey centers with watery, parchment-like borders, 3 to 6 mm. wide. Concentric rings of light and darker brown may be produced in the spots. Smaller spots seem to be limited by the larger veins but the larger spots coalesce, often covering the entire leaf. In the latter case the leaf is shrunken, somewhat curled, dried up like parchment and is opaque. The disease proved to be due to bacteria.

LEAF SPOT. The common frog eye spot of the tobacco caused by *Cercospora nicotianae* Ell. & Ev. is found generally in tobacco sections. Serious and extensive damage may be done to the lower leaves, especially in plantations where the plants are crowded. Lower badly diseased leaves should be collected and burned. Open planting should be practiced where practicable.

MOSAIC. The true mosaic disease has not been observed but an unimportant chlorotic condition is frequently noticed.

ROOT GALLS. Root galls caused by nematodes are frequently produced but no serious damage has been reported.

Oryza sativa RICE

FALSE SMUT OR LUMP SMUT. The conspicuous disease produced by *Ustilaginoidea virens* (Cke.) Tak. is found in practically all rice-growing sections. Only a few grains on each head are attacked. Diseased grains are characterized by the production of large sclerotia-like masses. Infected grains are enlarged, oval to spherical and from 2 to 6 mm. in the smallest diameter. The enlargement is due to the production of a sclerotial mass which in its early stages has a bright-yellow covering, but later is coated with a dark green powder composed of spores. No perithecia or ascospores have been observed in the sclerotial mass. During the damp weather the disease may be severe. It seems to be more prevalent on certain varieties of rice than on others.

GLUME SPOT. Dead and weakened plants are subject to the attacks of numerous fungi. The glumes of such plants are frequently covered with the minute pycnidia of *Phyllosticta glumarum* Sacc. but the fungus is undoubtedly saprophytic.

LEAF SPOTS. Elongated brownish spots are frequently produced on the leaves. These spots, when older, have ashen-grey centers and yield spores of a species of Cercospora. Dead and weakened leaves are also frequently spotted with the minute pycnidia of *Phyllosticta miurai* Miyaki.

STRAIGHT OR STERILE HEAD. The heads of certain varieties of rice are severely affected by a disease which just previous to maturity blasts grains and produces a whitish powder on the outer glumes. Fifty to one hundred per cent of the grains in a head may be affected. The kernels shrivel, and from a distance, the heads can be seen to stand up straight. The whitish powder produced on the outer glumes is made up chiefly of starch grains and the lemma and palet of the infected spikelets are discolored. Bacteria, *Oospora oryzetorum* Sacc. and other fungi are associated with the diseased grains but the specific cause has not been determined. Certain varieties appear to be immune to the disease.

Other fungi found on rice are *Entyloma oryzae* Syd., on weakened leaves; and on rotting straw are found the following: *Ophiobolus oryzinus* Sacc., *Spegazzinia ornata* Sacc., *Sordaria oryzeti* Sacc. and *Coniosporium oryzinum* Sacc. The blast or rotten neck and smut caused by *Piricularia oryzae* Cav. and *Tilletia horrida* Tak. respectively, have not been observed.

Cacara erosa SINCAMAS

RUST. This common garden vegetable is frequently attacked by *Phakospora pachyrhizi* Syd. The under surface of the leaves is covered with small, brown, raised, rust sori and frequently a brownish white dust of spores is produced over the leaf surface. The disease may be severe, causing defoliation.

Phaseolus spp. BEANS

BACTERIAL BLIGHT. *Pseudomonas phaseoli* Smith is common and destructive on *Phaseolus vulgaris* and *Phaseolus lunatus*. The leaves, stems and pods are attacked. Characteristic irregular brownish spots with water soaked edges are produced on the leaves. These spots may spread rapidly, killing the entire leaf. The spots during dry weather become papery and brittle. The organism attacks pods, forming the characteristic lesions, and also extends into the seed, thus infecting the latter. Entire fields of beans, especially those not acclimated, may be destroyed. The use of seed from disease-free pods is advised as a method of control.

BLACK MOULD. Frequently *Phaseolus calcaratus*, as well as other beans, may be covered with a black mould. The fungus is superficial, growing on the exudate of aphids and causes only slight damage.

BLIGHT. Beans may be severely affected with the Sclerotinia disease discussed under soy beans. *Phaseolus calcaratus* and *Dolichos uniflorus* are especially susceptible when planted too thickly and allowed to spread over the ground. Thin planting and training vines to poles, when possible, will retard the disease.

LEAF SPOT. *Cercospora lussoniensis* Sacc. is widely distributed on field, garden and lima beans. The spots are irregularly roundish, usually from 3 mm. to 1.5 cm. in diameter. The smaller spots are reddish brown while the larger lesions have an ashen grey center bordered with a reddish brown ring. The spots may coalesce, thereby covering large portions of the leaf surface. The spores are elongated and hyaline and the brownish conidiophores are in groups. The disease is moderately destructive but not enough so to warrant any definite control measures except general sanitation.

LEAF SPOT. *Phaseolus calcaratus* is frequently attacked by *Phyllachora phaseolina* Syd. The disease is characterized by the production of scattered lesions over the leaf surface. The spots are black, bordered with a straw colored ring, roundish, sometimes elongated, raised, and are made up of hard stromatic masses of the fungus which extend through the leaf. Within the stromata are produced one, or sometimes two, perithecia. The disease is not serious.

RUST. *Uromyces appendiculatus* (Pers.) Lk. is commonly found on *Phaseolus mungo*. Minute brownish, slightly powdery, raised pustules are produced on the lower surface of the leaves. Brown uredospores and black teleutospores are produced in the sori. The disease is not often serious, but may cause the loss of a considerable amount of foliage.

Other fungi of more or less importance have been observed on beans. On the ripened pods of *Phaseolus vulgaris* are found *Diplodia phaseolina* Sacc. and *Asteroma phaseoli* Brun. *Phaseolus lunatus* may be attacked just at the time of maturity by two fungi *Cladosporium herbarum* L. and *Diplodia phaseolina* Sacc. Sword beans *Canavalia ensiformis*, and horse beans *Canavalia gladiata* may be attacked by *Elsince canavaliae* Racib., *Gloeosporium canavaliae* Syd., *Physalospora guignardioides* Sacc. and *Cercospora canavaliae* Syd. The velvet bean *Stizolobium niveum*, may have its leaves attacked by *Cercospora stizolobii* Syd., and *Uromyces mucunae* Rabh. On dead Kultha beans, *Dolichos uniflorus*, may be found *Vermicularia horridula* Sacc. and *Didymella lussoniensis* Sacc.

Pisum sativum PEA

The garden pea is grown only in special localities of the Islands. Few diseases have been observed, though the powdery mildew is very destructive, covering the leaves, stems and fruit. As yet no perfect stage of the fungus has been observed.

Psidium guajava GUAVA

This fruit is not grown extensively on a commercial scale but is found growing wild.

BLACK MOULD. Leaves are often covered, chiefly on the upper surface, by a black mould, *Aithaloderma clavatisporium* Syd., undoubtedly growing on the exudate from aphids.

Aschersonia paraensis Henn. is a parasite on scale insects attacking the guava. The insects are killed by the fungus, which produces a yellowish, round, raised mat over the scales.

LEAF SPOT. *Pezizella ombrophilacea* Rehm. is a common fungus producing a leaf spot on the guava, but it is of relatively slight importance.

Diatrypella psidii Syd. has been found on twigs.

Psophocarpus tetragonolobus WINGED BEAN CALAMISMIS

ORANGE GALLS. *Woroninella psophocarpi* Racib., a fungus belonging to the Chytridiales, causes a destructive disease of the winged bean or calamismis, *Psophocarpus tetragonolobus*. The leaves, stems and pods are attacked. The lower surface of the leaves may be entirely covered with the yellowish to orange colored galls and they may appear also on the upper surface. The growth of the younger leaves is retarded and they assume abnormal shapes or become thickened. The characteristic orange galls are produced also on the stems, frequently checking their growth completely. The stems often become gnarled, twisted and abnormally enlarged. The galls covering the larger pods make them undesirable for use and the growth of the smaller pods may be checked or they may grow abnormally, producing malformed unsaleable pods. The yellow spots are the sporangia cases with sporangia.

Raphanus sativus RADISH

This radish which is eaten cooked, is extensively grown by the natives, but is seldom attacked by fungi.

BACTERIAL SOFT ROT. A bacterial rot of the roots frequently occurs. The soft rot appears to be similar to rots produced by *Bacillus caratovorus* Jones but no work has been done to determine the causal organism.

Saccharum officinarum SUGAR CANE

Sugar cane culture is very extensive in certain sections of the Islands.

LEAF SPOT. *Bakerophoma sacchari* Diedicke causes a very common and widely distributed leaf spot affecting the physiological functions of plants and thereby undoubtedly lowering the sugar content of the cane. The base of the leaf blade and the upper portion of the sheath on each side of the ligule are affected. On the lower leaf blade where the spots are confined chiefly to the mid-rib and are elongated parallel to it, the lesions are from 1 to 4 mm. in length and have a minute whitish center bordered with red. The whitish center, which is the fruiting body, is usually rounded and slightly raised. Similar spots are found on both surfaces of the leaf sheath and the leaf blade and a few may be found outside of the mid-rib. As a rule the spots do not spread to the lower portion of the sheath, or far out on the blade.

LEAF SPOT. A common leaf spot, most injurious during the rainy season, is caused by several species of the genus Cercospora. Generally not a great deal of damage is done to the cane but when the disease is abundant the vitality of plants is lowered, and the green sugar-manufacturing portions of the leaf are reduced, thereby lowering the sugar content of the cane. The outer and older leaves are most severely attacked, while the younger inner leaves are free from disease. The young lesions are at first irregular and yellowish but they become deep red to purple or the center becomes deep red to purple, surrounded with yellow. In extreme cases the lesions coalesce and enlarge, forming irregular long blotches which may cover a large portion of the leaf. On the underside of the leaves the spores appear in the lesions as light colored, grey to brownish masses.

LEAF SPOT. *Phyllachora sacchari* Henn. causes a rather uncommon and non-destructive leaf spot which is typical of the other Phyllachora diseases mentioned, in that a black stromatic mass, extending through the leaf, is produced. Stromata are sparingly scattered on the leaf surface. *Phyllachora sacchari spontanei* Syd. is found in greater abundance on the wild sugar cane, *Saccharum spontaneum*.

Other leaf spot diseases are present but they cause little or no damage.

STEM ROTS. The rot caused by *Thielaviopsis ethaceticus* Went. and the red rot caused by *Colletotrichum falcatum* Went. have not been observed on sugar canes in the Philippines. However, a reddening of the interior of unhealthy canes has been seen. This reddening also accompanies the early stages of the so-called rind disease with which *Melanconium sacchari* Massee is associated. It has not been determined whether *Colletotrichum falcatum* Went. is the actual cause of all the reddening of diseased canes

and *Melanconium sacchari* Massee is only secondary, following the Colletotrichum fungus.

The rind disease was common in many fields inspected. It causes most damage in fields which lack in vigor, due to poor cultural methods, and entire fields of cane may be killed by the fungus. In well kept and properly managed fields little damage is done. Diseased canes at first are prematurely yellowed and in early stages the interior of diseased canes may be reddened. In later stages it is browned. The tips of infected shoots shrivel, the leaves dry, and finally the entire cane shrivels and turns brown to black and the plant dies. During the early stages no fruiting bodies of the fungus have been observed, but in later stages they appear as minute black raised specks beneath the epidermis. These spots later burst open and under favorable conditions the spores are extruded in a curved mucilaginous thread-like mass from 1 to 4 mm. in length. No ascigerous stage has been observed nor have inoculation experiments been conducted to prove the pathogenicity of the organism associated with the disease.

ROOT GALLS. Root galls formed by nematodes are found, but little damage has been reported.

ROOT PARASITE. A flowering plant, *Aeginetia indica*, one of the broom rapes, may cause destruction of sugar cane. The plant is a root parasite, sapping the vitality of the sugar cane.

RUST. *Puccinia kuehnii* (Krueg.) Butl. *Uredo Kuehnii* (Krueg.) Wakk. & Went. is not abundant on the leaves of sugar cane and so far has done little injury. Characteristic brownish raised rust pustules are produced on the leaves.

SMUT. *Ustilago sacchari* Rabh. causes a true smut and seems to be epidemic in its attacks. Generally the disease does only slight damage in well cared for plantations but under conditions favorable for the fungus it may be destructive. The tips of young shoots are more usually attacked, and are developed into a long, slender, curved, shrunken, blackened, dusty mass. Often the diseased shoots are from 30 to 60 cm. in length. The disease may also extend down into the shoot, inside the mass of leaf sheaths. The fungus also occurs, often in abundance, on the wild sugar cane, *Saccharum spontaneum*. The spores of the fungus are single celled, spherical, and light brown.

SOOTY MOULD. Frequently leaves and even whole plants of sugar cane may be covered with a superficial black mould which is produced on the sugary excretion of aphids and mealy bugs. The fungus, which has not been determined, is not parasitic, but causes somes damage by shading and thereby prevents the functioning of the chlorophyll in the leaves.

Other fungi found on falling and dead sugar cane leaves are *Coniosporium vinosum* (B. & C.) Sacc., *Coniosporium extremorum* Syd., *Meliola arundinis* Pat., and *Apiospora camptospora* Penz. & Sacc.

Dictyophora phalloidea Desv. and a species of Marasmius have been observed growing from the roots near the base of the plants. These fungi are more common during the rainy season.

Sesamum orientale SESAME LINGA

LEAF SPOT. *Cercospora sesami* A. Zimm. is a common and destructive fungus, affecting leaves, petioles, stems and capsules of linga. The spots scattered over the leaf surface are from 1 to 4 cm. in diameter. They are irregularly circular, and have grey centers, bordered with brownish to purplish rings. They increase in size, form concentric rings of purplish brown, and coalesce until finally the entire leaf is covered. The spots on the petioles and stems are similar to those on the leaf except that they are somewhat more elongated and slightly sunken. The spots on the capsules are usually circular, sunken, and have grey centers bordered with brown.

POWDERY MILDEW. During certain seasons of the year linga leaves may be attacked by a powdery mildew. The upper and sometimes the lower surfaces of the leaves are covered with the characteristic powdery appearance. No ascospores have been observed.

Other fungi found on dead and dying stems are *Phoma sesamina* Sacc., *Gloeosporium macrophomoides* Sacc. and *Vermicularia sesamina* Sacc.

Solanum melongena EGG PLANT

BACTERIAL WILT. *Bacillus solanacearum* Smith which causes the bacterial wilt is common on all solanaceous plants in the Philippines. It is often the limiting factor in the production of egg plants. The disease is more fully described under tomato.

LEAF SPOT. *Phyllosticta hortorum* Speg. attacks the leaf and fruit of egg plants. On the leaf the characteristic irregular spots, with brownish-grey centers bordered with brown, are formed and numerous minute black pycnidia are produced in the center of the spots. Diseased fruits have large, irregular, sunken, light brown spots bordered with a darker, brownish ring. Within these sunken spots the pycnidia are produced in large numbers. The disease is most severe during the rainy season and the fruits may be entirely rotted by the fungus.

LEAF SPOT. *Sarcinella raimundi* Sacc. frequently attacks the under side of dying leaves of the egg plant, but it is not destructive. Small irregular blackish spots are produced by the fungus.

Diplodina degenerans Diedicke is found on rotted egg plant fruits.

Solanum tuberosum POTATO

Irish potatoes are not extensively grown in the Philippines on account of the adverse climatic conditions.

BACTERIAL WILT. *Bacillus solanacearum* Smith is particularly severe on potatoes, often limiting their production. The Irish potato is not acclimated to this country except in the high altitudes and consequently in its weakened condition it is subject to the attacks of soil bacteria.

BLACK LEG OR POTATO STEM ROT. The disease caused by *Bacillus phytophthorus* Appel is probably present in the Philippines. The characteristic symptoms of wilting and yellowing of leaves and the blackened, rotten stems and rotted tubers have been observed frequently. It is possible, however, that these symptoms are those of the bacterial wilt disease in a different stage of development.

Holcus sorghum SORGHUMS KAFFIRS MILOS

GRAIN MOULD. Sorghum grains are frequently covered with a dense black or sometimes dark-greenish mould, *Helminthosporium caryopsidium* Sacc. Infected grains seem to be destroyed and the damage may be severe. The mould is made up of mycelium, condiophores and the brownish, many-celled, curved conidia.

KERNEL SMUT. The smut caused by *Ustilago sorghi* (Lk.) Pass. is not serious but is present occasionally. Individual grains of the panicle are affected and diseased heads appear normal except for the infected grains. Smutted grains are much enlarged and have a black smutty mass of spores protruding from between the glumes.

LEAF SPOT. Sorghum leaves are badly attacked by *Phyllachora sorghi* v. Hoehn. which produces black spots thickly crowded over the surface. The spots are small, 1 mm. or less in diameter, roundish, sometimes elongated, raised, extending through the leaf to both surfaces, and are made up of hard stromatic masses of the fungus. The black stromata may be surrounded by a dark reddish or sometimes yellowish ring produced by the discoloration of the leaf tissue. Frequently the reddish spots run together, producing a much reddened leaf. Within the stromata are produced one or two perithecia which contain numerous asci and ascospores. The disease is frequently serious enough to render the leaves useless as fodder, as well as to lower the vitality of the plants.

RUST. Leaves of sorghum may be entirely covered with the sori of *Puccinia purpurea* Cooke. The disease lowers the vitality of the plants and renders them worthless for forage. The sori are brownish, raised, elongated, about 1 by 2 mm. or smaller, and are frequently surrounded by a dark reddish to purplish discoloration of the leaf tissue. Badly

infected leaves are discolored throughout. Uredospores are borne in large numbers but only a few teleutospores have been observed. The sori are at first closed but later become ruptured exposing the spores.

Another fungus, *Didymosphaeria amsoniera* Sacc., has been found on diseased leaves. *Fumago vagans* Pers. may be found on dying leaves.

Terminalia catappa TALISAY

Few fungi attack this commonly grown nut producing tree. *Ramularia catappae* Racib. causes a common but not destructive leaf spot and *Peroneutypella graphidioides* Syd. has been found on dead plants.

Theobroma cacao COCAO

BLACK ROT. This destructive disease caused by *Phytophthora faberi* Maubl. is responsible for 50 per cent of the losses of cacao in certain sections of the Philippines. The fungus attacks the fruit at any stage during its growth but the younger fruits suffer most. The first sign of infection on the pod is the development of a minute black spot, which gradually enlarges until the entire pod becomes blackened. At this stage a dense mass of mycelium producing conidiophores and conidia is formed on the surface. A cross section of a diseased fruit shows that the mycelium invades the rind and extends into the seed. Finally both rind and seed become rotted with a more or less dry rot. A microscopic examination of the diseased rind shows an abundance of oospores. The diseased pods may fall or remain upon the tree, drying and becoming mummified.

The rotting of diseased pods may be hastened by the entrance of other fungi. The fungi found on decaying fruits are *Fusarium theobromae* App. & Strunk, *Nectria bainii* Massee, *Lasiodiplodia theobromae* (Pat.) Griff. & Maubl., *Oospora candidula* Sacc., *Physalospora affinis* Sacc., *Aspergillus delacroixii* Sacc. & Syd., and *Mycogone cervina* Ditm. var *theobromae* Sacc.

Black rot of cacao pods can be controlled by sanitary measures and the use of Bordeaux mixture.

BROWN ROT. This disease of the pods found in other countries and supposedly caused by *Thyridaria tarda* Bancroft, has not been observed in the Philippines unless *Lasiodiplodia theobromae* (Pat.) Griff. & Maubl. is the imperfect form of the fungus. The latter occurs only as a secondary organism following chiefly the attacks of *Phytophthora faberi* Maubl.

CANKER. Canker diseases are common but a definite causal organism has not as yet been determined. Different species of Nectria have been observed, but their pathogenicity has not been established.

DIE-BACK. A die-back of young cacao twigs and limbs is found in the Philippines, but the causal organism has not been determined. Dead

twigs and limbs often bear the following fungi: *Botryosphaeria minuscula* Sacc., *Cyphella holstii* Henn., and *Ophionectria theobromae* Pat.

LICHENS. Lichens are very common on the trunk and branches. Their presence is not considered extremely harmful although they cover the lenticels and natural openings of the affected portions, thereby lowering the natural physiolcgical functions of the plant. A 6 per cent copper sulphate wash will remedy this condition.

ROOT DISEASES. Root diseases do not appear to be common but only limited observations have been made.

Vigna spp. COWPEAS

Phoma bakeriana Sacc. is found growing on the mature pods of cowpeas and the Sclerotinia blight, discussed under soy bean diseases, also occurs.

RUST. *Uredo vignae* Bres. may cause severe damage to the plants attacked but as a rule it is not common enough to be destructive. The fungus has also been determined as *Uromyces appendiculatus* (Pers.) Lk.

Xanthosoma sagittifolium YAUTIA

Yautia was mentioned before as a plant to replace the common Philippine gabis, the latter being badly infected with disease. Yautia is entirely free from attacks of *Phytophthora colocasiae* Racib. The fungus, *Vermicularia xanthosomatis* Sacc., produces a leaf spot of yautia but this disease is of little importance.

Zea mays CORN MAIZE

DOWNY MILDEW. A serious corn disease found in India, Java, the Philippines and undoubtedly other tropical countries is produced by *Sclerospora maydis* (Racib.) Butl. In Java, a recent worker has shown that the disease there is due to a species of Peronospora instead of the Sclerospora fungus but in the Philippines the same fungus described by Butler of India, *Sclerospora maydis* (Racib.) Butl., occurs. Apparently there are two corn mildews in the east, identical in appearance, but caused by two different fungi.

Downy mildew of corn is a serious disease in the Philippines, often killing entire portions of the fields. It is most severe during the rainy season. Young plants 30 to 60 cm. in height, first exhibit the disease and the upper younger leaves are the first to become affected. The lower leaves are not affected. Diseased leaves are characterized by the production of white stripes running parallel to the long axis of the leaf and young leaves are often entirely whitened. This chlorotic condition is due to the disappearance of the chlorophyll. On both surfaces of diseased leaves, more abundant however on the lower side, a downy appearance is produced by the mass of conidia and conidiophores. At a distance,

affected plants appear pale and stunted and have a bunchy growth, due to the checking of growth and frequently a shortening of the internodes. Such plants produce the male inflorescence prematurely. As a rule no grain is produced. Badly infected plants wither and die before the normal plants are ready for harvest.

The conidiophores are hyaline, thick, short, unbranched at the base, with short branches near the tip. On the end of the short branches are produced sterigmata, each of which bears a single conidium. The conidia are hyaline, thin-walled, spherical when young, but oval when mature and they germinate readily by the production of one to two germ tubes. Germinating conidia are found frequently on infected leaves. No oospores have been observed.

The method of infection and spread of the disease is unknown, therefore, no control measures can be recommended except sanitation by burning all infected plants.

DRY ROT. Kernels of corn on the ear are destroyed by a dense felty mass of mycelium. The diseased ears may be entirely covered with the fungus growth or only partially covered in blotches. Infected kernels burst open developing a whitish or pink mass of mycelium and the spores of a species of Fusarium.

LEAF SPOT. *Helminthosporium inconspicuum* C. & E. causes a common disease in the Philippines which at times may be very destructive. At the College of Agriculture entire plots of field and sweet corn have been destroyed. The disease is especially severe on newly introduced corn which is not acclimated and is in a weakened condition. Native corn is not severely attacked. The spots on the leaves are at first minute, brown, roundish and gradually increase in size, becoming somewhat oval, the long axis of the spot being parallel to the veins. The spots may increase in size, elongating into stripes or may run together, covering large surfaces of the leaf. Old spots and stripes have a lighter, yellowish to grey center bordered with brown. In the center of old spots is produced a black mould made up of brownish conidiophores and conidia. The conidia are large, septate and curved. A black mould is also produced on the tassel. Saccardo has determined this fungus as *Helminthosporium curvulum* Sacc., however, it produces a disease identical with the earlier described disease caused by *Helminthosporium inconspicuum* C. & E.

Clasterosporium maydicum Sacc. is found on corn leaves and is often associated with *Helminthosporium inconspicuum* C. & E. *Leptosphaeria orthogramma* (B. & C.) Sacc., *Broomella zeae* Rehm. and *Acerbia maydis* Rehm. are found on corn trash during decomposition. No rust fungi have been observed.

COLLEGE OF AGRICULTURE
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INHERITANCE OF ANTHRACNOSE RESISTANCE AS INDICATED BY A CROSS BETWEEN A RESISTANT AND A SUSCEPTIBLE BEAN[1]

G. P. McRostie

The study of the definite inheritance of disease resistance has been done chiefly in late years and even yet the literature on the subject is decidedly limited. Biffin (1) in 1905 found that resistance to the yellow rust (*Puccinia glumarum* Eriks. & Henn.) in his cross between Rivet, a slightly susceptible wheat, and Red King, an extremely susceptible one, behaved as a recessive, giving all susceptible in the F_1 and approximately seventy-five per cent susceptible in the F_2 generation. Vavilor (2) in crosses between Persian wheat (*Triticum vulgare* var. *fuliginosum* Al.) which was immune to mildew (*Erisiphe graminis* D. C.) and varieties of common bread wheats susceptible to this disease, secured F_1 hybrids which were immune to the mildew. Stuckey (3) in breeding varieties of tomatoes resistant to blossom-end rot found that resistance was transmitted as a dominant character. Nilsson-Ehle (4) in crosses between wheats resistant to yellow rust (*Puccinia glumarum* Eriks. & Henn.) and varieties susceptible to this disease found susceptibility dominant in the F_1 and was of the opinion that a multiple factor explanation of the genetic behavior of resistance was the correct one in his crosses. Tisdale (5) studying the inheritance of flax wilt (*Fusarium lini* Bolley) in crosses between resistant and susceptible flax varieties, obtained a great variety of results grading all the way from F_1 generations that were wholly resistant to F_1 generations that were wholly susceptible. He attempts to explain his results on the basis of multiple factors, claiming that under normal conditions two or three factors in the homozygous condition would be enough to show apparent resistance. Under conditions exceptionally favorable for infection only those plants which had all factors concerned in the homozygous condition would show resistance. The gradation in the F_1 results might therefore be explained on the basis of severity of infection. Burkholder (6) in crosses between Wells' Red Kidney, a type of bean resistant to both physiological strains of anthracnose (*Colletotrichum lindemuthianum* (Sacc. & Magn.) Bri. & Cav., and a white marrow bean

[1] Paper No. 77, Department of Plant Breeding, Cornell University, Ithaca, New York.

resistant to only one of these strains, obtained in the F_2, out of a total of 473 plants tested, 362 which proved resistant and 111 which proved susceptible to this disease. These numbers show almost an exact 3 : 1 ratio and indicate a single factor difference between the resistant and susceptible plants with respect to the one strain of anthracnose concerned in the cross.

MATERIAL AND METHODS

The work reported in this paper was begun at Cornell University under the direction of Dr. Emerson of the Department of Plant Breeding and Dr. Barrus of the Department of Plant Pathology, to each of whom grateful acknowledgment is here given for material and helpful advice. The object in view was to study the inheritance of the resistance factor of bean anthracnose and at the same time to secure a commercial type of white pea bean that was resistant to this disease. The practical aspect of securing resistant strains of any variety of plant is often complicated by the existence of different physiological strains of various disease producing organisms. The existence of two such physiological strains of *C. lindemuthianum*, which for convenience he labeled "A" strain and "F" strain, has been proved by Dr. Barrus (7) (8) to exist in the case of bean anthracnose. The resistance and susceptibility to these two strains of a great many varieties of beans has been worked out by him. Only one variety, Wells' Red Kidney, a vigorous growing bush bean a little late in maturing and having reniform slightly flattened seed of a self red color, was known at the time this work was begun to be resistant to both strains. This variety then formed the easiest starting point for the breeding of a disease resistant white pea bean. The other parent used in the crosses was a selection (P.B. No. 1986)[2] of Michigan Robust, a vigorous growing, heavy yielding, somewhat flat, white pea bean. This bean is resistant to the "F" strain but very susceptible to the "A" strain of anthracnose. The marked difference in seed and growth characters of these two varieties greatly complicates the process of securing a desirable type of white bean from the F_2 segregates. Pure lines of both varieties were used, however, thus simplifying the problem as much as possible.

About twenty pots of each of these varieties were planted in the greenhouse at Cornell University in the fall of 1916. In February 1917 a second planting was made and from this planting about sixty seeds from reciprocal crosses were obtained. Two seeds from the fall crosses were also planted and produced fifty F_1 seeds. All of these seeds were planted the latter part of May of that summer in the Plant Breeding garden at the University.

[2] A selection of Michigan robust bean tested for four years by the Plant Breeding Department of Cornell University under the serial number 1986.

During blossoming time the beans were covered with a heavy netting to prevent any chance cross pollination by bumble bees. The number of F_1 seeds obtained in the greenhouse was so small that the writer decided to grow these through without testing them for resistance to anthracnose. They could then be inoculated at the same time as the larger number of F_2 families coming on. Their F_2 genetic constitution with regard to disease resistance could also be deduced from their reaction to the inoculation in the F_3.

Observations on the F_1 and F_2 generations

The F_1 plants were vigorous growing pole bean types, very heavily podded, as high as one hundred pods being obtained from a single plant. The seeds were invariably intermediate in size and shape between the pea and kidney parents. They were of a dark navy blue to black color frequently with numerous tiny white specks. According to Emerson (9) the factor for the black color enters into the cross from the white parent, which parent, however, lacks the factor for pigmentation. On coming in contact, in the hybrid generation, with this pigmentation factor possessed by the colored parent the black color becomes evident.

The F_2 plants, grown under the screen at the same time as the F_1 generation presented a great variety of types both as to growth characters and color, shape and size of seed. As had been found by Emerson (10) in a previous work, the color character segregated in the proportion of three colored to one white, while the growth habit segregated in the proportion of three climbing to one of bush habit of growth. Within the 75 per cent of colored seeds were found a great variety of colors. The bush and climbing types also gave a wide variation within their respective classes. The inheritance of the size and shape of seed did not follow any simple ratio.

Disease resistance

A few seeds from the F_2 plants were tested for anthracnose resistance in the Plant Breeding greenhouse during the fall of 1917 and spring of 1918. By far the greater number, however, were taken to the bean laboratory at Perry, New York, to be tested along with over two thousand seeds from the F_1 plants grown in the plant breeding garden in the summer of 1917. For inoculation in the greenhouse the beans were planted in two inch pots, only one seed being planted to each pot. When the young bean seedlings had developed two large leaves they were wet down thoroughly with water and then sprayed with a spore suspension of the anthracnose producing organism. As both parent types were re-

sistant to the "F" strain of the fungus it would only have been necessary to use the "A" strain for the inoculation of the progeny of this cross. However, both strains were used as a further check on the resistance of the parent types, some of which were always planted with the F_2 seeds to be inoculated. Besides the parent types the common red kidney was used as a check on the virulence of the "F" strain of the fungus. After being inoculated the plants were placed in a moist chamber and kept extremely moist for forty-eight hours. At the end of this time they were removed to the greenhouse bench and treated in the ordinary manner. After approximately ten days the susceptible plants could be easily picked out by the numerous lesions of the disease which had appeared on their leaves and stems. At Perry, the same procedure was followed except that the pots were put in a cold frame and left there until ready to transplant. After the plants were inoculated the cold frame was covered with cheese cloth which was left on during the period necessary for infection to take place, after which time it was removed. At the end of from ten to twelve days the resistant plants were transplanted into the field and the susceptible ones discarded.

The following tables give in tabular form the results obtained from the inoculations.

Table 1 gives the result of the inoculation of 1970 F_2 plants which germinated, out of a total of 2200 seeds planted. Considerable deviation occurs, in some families, from any constant ratio. This deviation might be expected from the fact that some of the families had such small numbers and also because of the fact that in a large bed it is very hard to obtain conditions for infection uniform in all parts of the bed. Plants which were under conditions extremely favorable for infection would show some lesions even though they were as resistant as the kidney parent. On the other hand susceptible plants under conditions unfavorable for infection would show apparent resistance. Quite a number of the families show a close approximation to a 3 : 1 ratio between resistance and susceptibility with resistance dominant. The totals for all of the families bear this out by giving numbers differing by considerably less than the probable error from those to be expected with such a ratio.

Table 2 gives the results of the inoculation of the F_3 families heterozygous for disease resistance. To bear out a 3 : 1 ratio hypothesis these should give the same general segregation as the families of the F_2 generation. Here also quite a number of the individual families as well as the totals for all the families approximate very closely a 3 : 1 ratio with resistance again dominant.

In tables 2, 3 and 4 the F_3 families are divided into three classes: those that gave both resistant and susceptible plants, those that gave all re-

sistant plants, and those that gave all susceptible plants. Their probable genetic formula with respect to disease resistance in the second generation is assumed from their behavior under inoculation in the F_3 generation.

TABLE 1

Results of inoculating the F_2 plants

PEDIGREE NUMBER	RESISTANT	SUSCEPTIBLE
56-1	48	26
65-1	95	41
65-2	78	35
65-3	72	14
67-1	28	3
69-1	75	13
69-2	9	2
71-1	22	12
71-2	7	2
73-1	86	18
74-1	12	5
74-2	109	23
74-3	79	34
76-1	66	32
76-2	49	19
76-3	73	30
77-1	39	16
77-2	30	9
77-3	17	3
77-4	65	17
78-1	19	16
78-2	74	33
79-1	66	20
79-2	9	3
79-3	12	9
79-4	20	6
79-5	9	0
80-1	42	15
80-2	50	15
80-3	26	10
81-1	85	18
Totals	1471	499
Expected numbers	1477.5	492.5
Difference	6.5±12.963	

The letters designating the different strains of anthracnose were used to indicate the genetic formula of any plant with regard to its resistance or susceptibility to either of these strains, capital letters being used to in-

TABLE 2

Results of inoculating the F_3 families heterozygous for disease resistance

PEDIGREE NUMBER	RESISTANT	SUSCEPTIBLE
57-2	5	3
57-6	72	24
57-8	77	35
57-10	20	8
57-11	34	15
57-12	43	17
57-13	8	6
57-16	52	12
57-18	2	3
57-20	17	6
57-24	7	4
57-25	7	4
57-33	19	6
57-34	3	3
58-4	25	7
58-8	58	10
Totals	449	163
Expected numbers	459	153
Difference	10 ± 7.2291	

TABLE 3

Results of the inoculation of F_3 families evidently homozygous for disease resistance

PEDIGREE NUMBER	RESISTANT	SUSCEPTIBLE
57-1	11	1 v.s.
57-3	34	3 v.s.
57-7	27	1 v.s.
57-9	13	1 v.s.
57-21	25	3 v.s.
*57-26	6	0
*57-31	10	0
57-32	39	4 v.s.
*58-2	8	1 v.s.

v.s. The infection on plants marked in this manner was very slight—not more than often occurs on the resistant parent under conditions very favorable for infection.

* The numbers in these classes are rather small for drawing definite conclusions. However, the odds seem to favor their belonging to the genetic class indicated.

dicate the presence of the factor producing resistance and small letters the absence of this factor. Thus the resistant parent would be homozygous for resistance to both strains of *C. lindemuthianum* and hence would be designated by the formula *AAFF*. The susceptible parent being susceptible to A strain but resistant to F strain would be represented by the genetic formula *aaFF*. The F_2 generation of this cross would, therefore, all be homozygous for the *F* factor but would have three possibilities with regard to the *A* factor; plants homozygous for the *A* factor, plants

TABLE 4

Results of the inoculation of F_3 families evidently entirely susceptible

PEDIGREE NUMBER	RESISTANT	SUSCEPTIBLE
*57-4	0	6
57-15	0	15
57-19	0	32
57-22	0	16
*57-23	0	7
57-29	0	15
57-30	0	14
58-3	0	13
58-5	0	27
58-6	0	10
58-7	3+	135

*See note under table 3.

+These plants were near a small open spot in the frame of the bed and evidently by their location escaped infection.

TABLE 5

Summary of the F_2 plants as indicated by the F_3 results

	HOMOZYGOUS RESISTANT AAFF	HETEROZYGOUS RESISTANT AaFF	SUSCEPTIBLE aaFF
Observed numbers	9	16	11
Calculated numbers	9±1.753	18±2.023	9±1.753

heterozygous for this factor or plants lacking it altogether. According to the three possibilities indicated all of the plants would fall into one of the following three classes: those homozygous for the *A* factor as in table 3 and therefore resistant, those heterozygous for the *A* factor as in table 2 and therefore breaking up in the F_3 into resistant and susceptible plants, and those lacking the *A* factor as in table 4 and therefore entirely susceptible.

Table 5 gives the summary of the resistance and susceptibility of the F_2 plants grown in 1917 as indicated by their F_3 inoculation results re-

corded in tables 2, 3, and 4. With these plants also the observed numbers of plants agree very closely with the expected numbers if only a single factor difference exists between resistance and susceptibility in this particular cross.

The ratios obtained throughout between resistant and susceptible plants indicate quite clearly a single factor difference between resistance and susceptibility to the one strain of anthracnose concerned in the cross. The fact that resistance is dominant makes it more difficult to secure resistant types from the F_2 segregates as it is necessary to grow all resistant F_2 plants through to the F_3 generation in order to tell whether they are homozygous or heterozygous for resistance.

A number of white resistant types have been isolated from the families reported in table 3. A few white types have also been isolated from the plants recorded in table 2 but these will have to be inoculated again in the fourth generation in order to separate the types which are homozygous from those which are heterozygous for resistance. The different types are being grown exclusively in pedigree culture, individual records being made of each promising plant in order that strains of desirable yielding qualities and growth characters may be isolated as soon as possible. The process is necessarily slow, but two generations of some of the more promising types are being grown in the greenhouse during the fall and winter months.

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BRIEFER ARTICLE

ADDITIONAL VARIETIES OF BEANS SUSCEPTIBLE TO MOSAIC

DONALD REDDICK AND V. B. STEWART

In a recent issue of PHYTOPATHOLOGY[1] the writers published a list of varieties of bean which were found by artificial inoculation to be susceptible to the mosaic disease. Practically all of those varieties now have been tested under field conditions and in addition some other varieties have been included. Of the susceptible varieties as listed, fortuitous circumstances prevented a field test of the varieties Wardwell kidney wax, Burpee stringless, Hodson green pod and London horticultural. The remaining varieties proved susceptible when inoculated in the field.

The following additional varieties have been tested in the field and found susceptible: *Phaseolus vulgaris*, black-eyed wax,[2] Detroit, German black wax, Keeney rustless, Lima wax, prolific black wax, rust-proof intermediate horticultural, China red eye, early refugee, snowflake, white marrow, vineless marrow, red marrow, small white (of California), blue pod, pink, western red kidney, golden champion, Tennessee wonder, Burger stringless, Scotia, Worcester mammoth, Bayo, Mexican pinto; *Phaseolus lunatus macrocarpus*, long pod; *Phaseolus acutifolius latifolius*, Tepary; *Vicia faba*, horse bean, winter horse bean.

The following varieties (names supplied by dealer), said to be Manchurean beans, have been found susceptible: Chunagauzura, Nagauzura, Kotenashi, Chutenashi, Muroingen, Diafuku, Kintoki, Kumamotoingen.

Of the varieties listed previously as possibly resistant or immune to the disease, it will be seen that three have passed over to the susceptible list —Detroit, China red eye and white marrow. Unfortunately the varieties Arlington red cranberry, creaseback and white runner failed to grow in the field and have, as yet, received no further test. The variety robust was given particular attention and many plants in eleven different lots of the variety were inoculated. No mosaic developed in any of the lots. Two selections of robust showed some indications of mosaic but such plants

[1] Phytopath. **8**: 530–534. 1918.

[2] The names of varieties are those employed by Jarvis, C. D., American varieties of beans. Cornell Univ. Agr. Exp. Sta. Bul. 260. 1908; by Hendry, G. W., Bean Culture in California. California Agr. Exp. Sta. Bul. 294. 1918; or, in several cases, it is the one employed by introducer, dealer or importer.

failed to communicate the disease upon inoculation to a highly susceptible variety.

No other varieties of *Ph. vulgaris* have been found which possess immunity although definite decision on certain varieties is reserved until further tests can be made. The following varieties in related species have been tested in the field and fall in the immune or highly resistant class: *Dolichos lablab*, hyacinth; *Cicer arietinum*, Garbanzo; *Vigna sinensis*, black-eye; *P. aconitifolius*, moth bean; *P. aureus*, Mung bean; *Canavali ensiformis*, Jack bean.

In the above tests the plants were grown in long rows in the field. The first inoculations were made June 29, 1918, at a time when the juvenile leaves were fully expanded. Any plants showing mosaic from seed were removed and subsequent observation attested that practically all such disease was in evidence at that time. Leaves from diseased plants were crushed together and used to rub the under sides of juvenile leaves on from six to ten plants of each variety. The leaves were rubbed hard enough to make an evident injury. The inoculations were made late in the evening and the night and following morning were foggy. Records were taken on July 23, at which time, except in rare instances, only inoculated plants and not always all of the inoculated ones, showed symptoms of the disease. All diseased plants were removed. Varieties which did not show mosaic, or which were too small to inoculate the first time, were inoculated on July 26 or July 30. On the latter date there was no indication that any external agents had interfered in any way with the experiments, although a number of different insects were abundant on the plants. On August 20, when it was time to record the results of the second sets of inoculations it was found that from a few to many plants in most of the varieties, whether inoculated or not, were showing the disease. This of course throws doubt on the success of the later artificial inoculations but adds another inoculation, natural in character, which increases the probability of the accuracy of the above data, particularly with reference to those varieties listed as immune or resistant.

RELATIVE SUSCEPTIBILITY OF VARIETIES

Some idea of the relative susceptibility of the different varieties under test was gained from the above experiments. The occurrence and severity of the disease from natural inoculation is taken as the best available indication of relative susceptibility. Highly susceptible plants show a suppression of the smaller veins on the upper side of the leaf, marginal crimping which results in cupping the leaf downward, the formation of lumps, warts or wrinkles on the upper side of the leaf and the appearance of a

pronounced mosaic of dark green and pale green leaf tissue. Prolepsis and dwarfing, when either occurs in conjunction with other symptoms are regarded as indications of extreme susceptibility. Contrasted with such symptoms some varieties show almost total absence of these characters or only a single one. The extreme condition has been described in the previous article in the discussion of the variety white marrow.

It may be considered, perhaps, that since the presence of this disease tends to suppress that all-important, biologic (and incidentally economic) function—seed production, the relative yield of plants ought to be regarded as the most important index of susceptibility. Unfortunately it is impossible to make such a test in the field and do it in a manner that would yield results having any degree of accuracy. Healthy and diseased plants would have to be replicated in alternate rows and the natural agents of inoculation are not yet known so that a suitable location for such an experiment outside of a screened greenhouse can not be chosen.

There are indications, at least in some cases, that severity of infection as manifested by foliage symptoms is correlated with the yield of mature seeds. This is to be noted in the varieties navy pea, Burlingame and white marrow; navy pea shows very marked foliage symptoms and very large reductions in yield; Burlingame shows somewhat less markedly the foliage symptoms and matures somewhat more pods; the white marrow shows very much suppressed symptoms on the foliage and seed production does not seem to be reduced greatly. On the other hand a wax-podded variety has been observed which appeared to present an extreme infection but which nevertheless produced an abundance of pods. Another point to be borne in mind in examining the subjoined list is that some of the varieties were grown out of their most favorable environment and for that reason probably responded differently to the disease than they otherwise would.

On the basis of foliage characters, as indicated above, the following varieties arranged in descending order are regarded as highly susceptible: navy pea, small white, Lady Washington, Nagauzura, Kumamotoingen, Canadian wonder, black valentine, Burlingame, Worcester mammoth, red kidney, Well's red kidney. On the same basis the following varieties, arranged in descending order, are regarded as resistant: Red marrow, white marrow, long pod, Keeney rustless, German black wax, blue pod, Michigan white wax, rust-proof intermediate horticultural, refugee wax, prolific black wax, scarlet flagelot, red valentine.

This leaves a number of varieties which eventually may fall in one or the other class or may remain in an intermediate position.

A fourth class of immune varieties contains without doubt robust and several varieties in other species of Phaseolus and in other related genera.

There remains a considerable number of varieties, some of them possessing good qualities and constituting good foundation stock, which have not been tested. More varieties should be tested but in the meantime at least one variety of *Ph. vulgaris* and a few varieties in related species and genera possessing immunity may be used as a starting point for improving other sorts.

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PHYTOPATHOLOGICAL NOTES

The isolation of fungi from manufactured sugars. The fungi isolated with the greatest frequency from the principal types of sugar belonged chiefly to the Aspergilli and Penicillia. *Aspergillus niger*, a blue Aspergillus, and Cladosporium were isolated from practically all samples. The first two named were active in deteriorating sugar, as proven by later experimentation. No definite flora could be assigned to any particular type of sugar, although the lower grades of sugar appeared to have the greatest infection with regard to both number and variety.

Czapek's agar proved superior to eight other media for isolating a variety of organisms from sugar. A modification by the authors gave a more rapid colony development.

A bulletin covering these results in detail is soon to be published.

NICHOLAS AND LILLIAN KOPELOFF.

Personals. Mr. Edw. C. Johnson, dean of the Division of Extension of the Kansas State Agricultural College, has resigned to accept the position of dean of the College of Agriculture and director of the Experiment Station, Washington State College, Pullman, Washington.

Mr. Johnson was connected with the cereal disease work of the Department of Agriculture from 1907 to 1912, and for four years was in charge of this work. In 1912 he was elected superintendent of institutes and demonstrations, Kansas State Agricultural College, and was made dean of the Division of Extension at the same College in 1915.

Mr. J. A. McClintock has resigned his position as extension specialist in cotton, truck, and forage crop diseases in Georgia, to which he was appointed under a cooperative agreement between the United States Department of Agriculture and the Georgia State College of Agriculture, and has become plant pathologist and botanist of the Georgia State Experiment Station, with headquarters at Experiment, Georgia.

Mr. S. P. Doolittle has received his discharge from the Army and has been reinstated to his former position in the United States Department of Agriculture as pathologist in extension work on the control of truck crop diseases in Wisconsin, with headquarters at Madison.

Dr. M. W. Gardner has resigned the position of assistant pathologist in the Bureau of Plant Industry to take up the investigation of vegetable diseases at the Purdue University Experiment Station, LaFayette, Indiana, beginning February 1.

New institute of research in phytopathology. The Laboratory of Plant Pathology formerly located at the Royal Botanical Gardens in Kew, England, has recently been transferred to the Rothamsted Experiment Station at Harpenden, where a large new Institute of Research in Phytopathology is being created. Professor W. B. Brierly will be the director of the department of plant pathology, Dr. Innis director of the department of entomology, Dr. Goodey in charge of the department of helminthology. The directors of the other departments have not yet been appointed. Professor Brierly will greatly appreciate the cooperation of American plant pathologists in his efforts to assemble a phytopathological library in the institution. He will be glad to establish exchange relationships with the different institutions in this country.

H. H. WHETZEL.

LITERATURE ON PLANT DISEASES[1]

COMPILED BY EUNICE R. OBERLY, LIBRARIAN, BUREAU OF PLANT INDUSTRY, AND FLORENCE P. SMITH, ASSISTANT

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All authors are urged to cooperate in making the list complete by sending their separates and by making corrections and additions, and especially by calling attention to meritorious articles published outside of regular journals. Reprints or correspondence should be addressed to Miss E. R. Oberly, Librarian, Bureau of Plant Industry, U. S. Dept. of Agric., Washington, D. C.

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